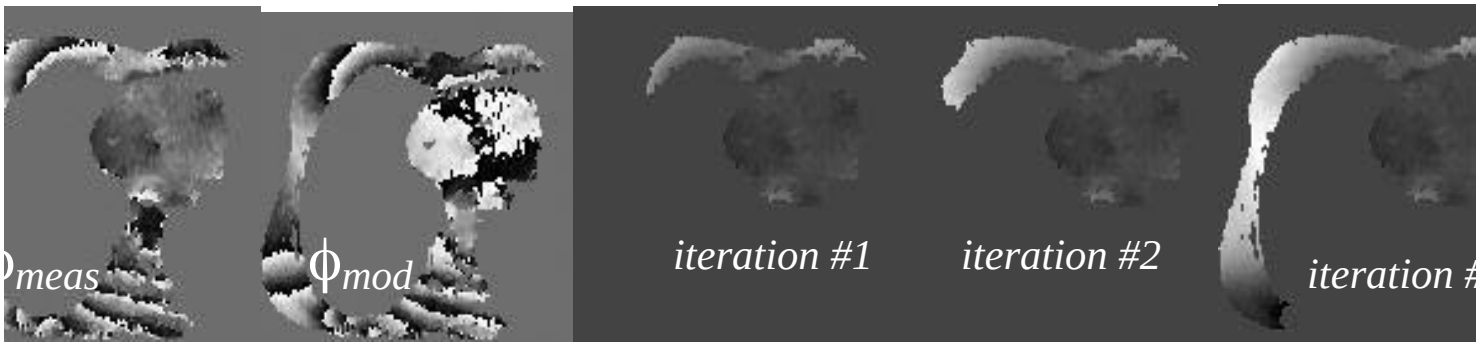
g **GE Medical Systems**
Abstract for phase problem conference
LBL, May 17-19, 2001

SK Patch
3200 North Grandview Blvd., W-875
P.O. Box 414, Waukesha WI 53188
Phone: (262)521-6577
e-mail: sarah.patch@med.ge.com

Robust Phase Unwraping

Open MRI systems suffer poor S/N, leaving many phase errors in phase difference images which reflect the degree of inhomogeneity in an imaging volume. Prescan shimming requires that we unwrap robustly, preventing phase errors from "streaking" across the final image. We unwrap chunks of the phase difference image at a time, using another "modulated" phase difference image to determine the phase of questionable pixels near wraps. It is only possible to measure phase the phase difference image modulo 2π, *i.e.*, $\phi_{meas} = \phi \bmod 2\pi \quad \ddot{e}\,[0, 2\pi)$ Our task is to recover the "unwrapped" image, ϕ_{UW}, from ϕ_{meas}. To do this robustly, we create another phase image, ϕ_{mod}, which clearly shows how to treat questionable pixels near phase wraps in $\phi_{meas,}$ where $\phi_{mod} = (\phi + \pi) \bmod 2\pi \quad \ddot{e}\,[0, 2\pi)$

See Figure 1 for examples of both wrapped phase difference images. The phase wraps of this "modulated" image lie between the wraps of the original image, ϕ. Unwrapping is done iteratively, by "patching" smooth sections from one image (either ϕ_{meas} or ϕ_{mod}) onto the final unwrapped image, ϕ_{UW}. To initialize ϕ_{UW}, we simply take the largest unwrapped section of $\phi_{meas.}$ This unwrapping technique unwraps nonconvex connected image regions and can be applied in any dimension.



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SK Patch
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03/21/01